AI System for Monitoring and Reporting Safety Violations at Workplace

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Aim

To develop an AI-based system capable of monitoring workplace safety by detecting personal protective equipment (PPE) compliance using real-time video feeds, enhancing low-quality images, and providing immediate alerts upon violation detection through automated voice announcements.
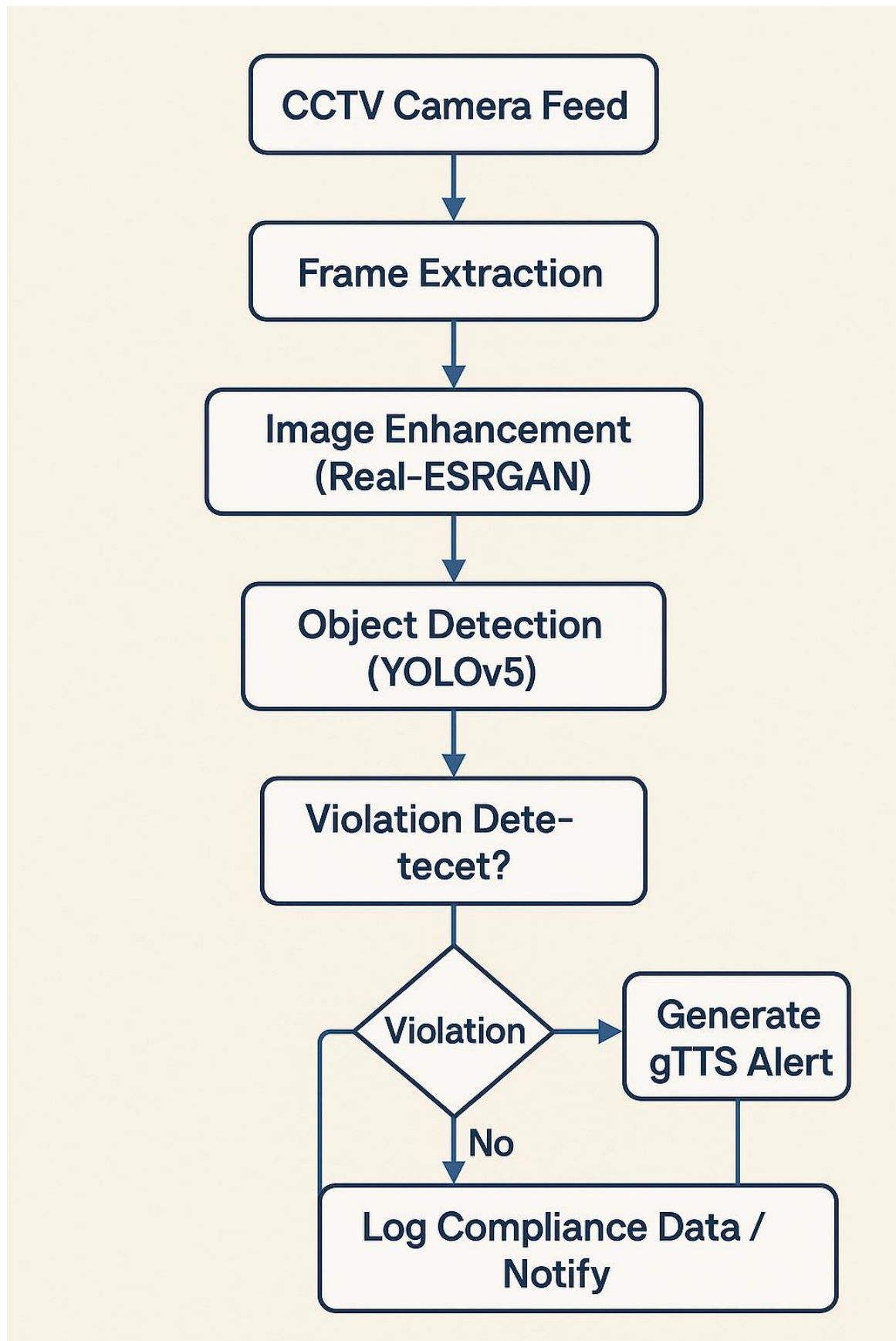
Objectives

- To detect the presence or absence of safety equipment such as helmets, vests, and gloves using object detection.

- To enhance the clarity of video footage using super-resolution techniques for accurate violation analysis.

- To generate voice alerts in real time upon detection of safety violations to warn workers or alert supervisors.

- To ensure efficient and scalable monitoring of safety compliance using deep learning models and automation.

Scope

- The system is designed for industrial and construction environments where adherence to PPE is mandatory.

- Real-time video surveillance integrated with object detection enables automatic detection of non-compliance.

- Super-resolution using Real-ESRGAN improves the accuracy of object detection in poor-quality images or low-light environments.

- Integration of text-to-speech (TTS) using gTTS allows for immediate auditory warnings and alerts.

- The project leverages a dataset of 30,000 PPE images to train and validate the YOLOv5 model for high accuracy and robustness.

4. System Architecture Diagram

```
CCTV Camera Feed
        ↓
Frame Extraction
        ↓
Image Enhancement
(Real-ESRGAN)
        ↓
Object Detection
(YOLOv5)
        ↓
Violation Dete-
tecet?
        ↓
    Violation → Generate
                gTTS Alert
        ↓ No        ↓
Log Compliance Data /
Notify
```

Workflow

1. **Data Collection and Preprocessing**

   o Used a dataset of 30,000 PPE images labeled for safety gear (helmets, vests, gloves, etc.).

   o Images are cleaned, augmented, and split into training, validation, and testing sets.

2. **Image Enhancement**

   o Real-ESRGAN is used to enhance image resolution before detection.

   o Helps improve accuracy in detecting PPE in blurry or low-light video feeds.

3. **Object Detection with YOLOv5**

   o YOLOv5 is trained on the PPE dataset.

   o Model detects individuals and verifies if required PPE is present.

4. **Violation Detection Logic**

   o If any required PPE is missing, the event is flagged as a violation.

5. **Voice Alert using gTTS**

   o Upon detection of a violation, a voice message is generated using gTTS (Google Text-to-Speech).

   o The message can be customized to specify the nature of the violation.

6. **Reporting and Logging**

   o All detected events are logged with timestamps.

   o Optional: integration with a dashboard or notification system for real-time monitoring.

Conclusion

This AI-powered safety monitoring system provides a robust, real-time solution to ensure workplace safety compliance. By integrating advanced computer vision techniques, image enhancement, and automated alerting systems, it minimizes the risk of human oversight and ensures a proactive approach to occupational safety.